*BASIC INFORMATION*

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# EARTHQUAKE, WIND RESISTANT AND FIRE RESISTANT PRE-FABRICATED BUILDING PANELS AND STRUCTURES FORMED THEREFROM

## BACKGROUND OF THE INVENTION

This invention relates to an earthquake, fire and wind resistant pre-fabricated building panel for use in making a three-dimensional structure such as a house, apartment, office building or the like. A plurality of panels according to the invention is illustrated and described, a method of making such panels is described, examples of three dimensional structures according to the invention are described and a specially adapted shipping container for shipping components to build a three-dimensional structure is described.

### Prefabricated Panels

Prefabricated building panels, in general, act as building components which can be quickly and easily fastened to a pre-erected frame structure. Many man-hours, however, are required to pre-erect the frame structure and prepare such structure for receipt of prefabricated panels. Dimension tolerances in both the pre-erected frame and the prefabricated panels can accumulate over large spans and ultimately, the panels may not properly fit on the pre-erected frame.

In addition, conventional pre-fabricated panels are normally fastened to the exterior side of the pre-erected frame which enables such panels to withstand positive wind loading, however, negative wind loading such as created by hurricanes cannot be withstood.

Negative loading normally results in the exteriorally fastened panels being ripped off of the frame structure. This also occurs with conventional plywood board sheathing which is also fastened to the exterior side of the frame. Examples of such prior art prefabricated panels susceptible to negative wind loading are given in U.S. Patent No. 4,841,702 to Huettemann and in U.S. Patent No. 4,937,993 to Hitchins. What is desirable therefore is a building panel or building system which can withstand both positive and negative dynamic loading.

Three Dimensional Structure

A consideration in most building designs is the susceptibility of the building to seismic forces such as created by earthquake activity. Many conventional building designs include a solid, unitary cast concrete foundation with engineered footings suitable for the soil upon which the building is to be erected. The building frame, in the form of integral wall portions connected together, is built upon the solid unitary foundation and plywood board sheathing or prefabricated panels are fastened to the frame. (Of course the plywood board sheathing and prefabricated panels suffer from the disadvantages pointed out above).

The solid unitary foundation presents a problem under seismic forces because it is unitary and rigid. Although this permits such forces to be transmitted throughout the foundation, such a rigid foundation is unable to act sufficiently resiliently and elastically to absorb such forces without cracking or breaking. Cracks or breaks in the foundation are susceptible to water ingress which can have a tendency to cause the crack or break to propagate through the foundation resulting in degradation of the foundation.

In addition, the integral wall portions of the frame of the structure typically are formed of wood which is nailed together. Often seismic forces are sufficient to rip apart nailed walls resulting in localized failure of the frame leading to collapse of a wall and potential collapse of the building. While a wood frame of this type presents a relatively resilient elastic structure, typically the joints between frame portions are not sufficiently strong to hold the frame portions together under such loading and thus seismic forces cannot be properly distributed to other portions of the frame to help share the load. What is desirable therefore is a sufficiently resilient elastic building foundation and a sufficiently resiliently elastic frame structure able to withstand and distribute seismic forces.

Hi-rise apartment or office buildings sometimes also suffer from a lack of a sufficiently resiliently elastic foundation and frame structure and, wall panels and partitions able to withstand and distribute earthquake forces. Thus it is desirable to provide such ability in hi-rise apartment and office buildings or virtually in any structure exposed to such forces.

In addition to the need to withstand earthquake forces, there exists a need to provide prefabricated building structures capable of quick and easy erection with minimal labour requirements. Presently, conventional easily erected building structures include prefabricated

structures such as trailers, mobile homes etc., which are transported to the erection site. Transporting such structures is costly and requires an enormous amount of space on a ship, for example. If it were possible to ship individual components of a structure and then erect the structure quickly and easily, shipping or transportation costs would be reduced, labour requirements for erecting the structure would be reduced and the cost of erecting the structure itself would be reduced. Thus it is desirable to provide building components which are capable of providing these advantages.

Transportation

Further to the transportation of conventional prefabricated building structures such as trailers, mobile homes and modular homes, such items are normally stacked one upon the other during shipping. Typically, however, these structures are designed only to bear their own weight and cannot bear the weight of other such structures, especially while the ship on which they are carried is travelling in rough seas. Thus, additional structural support is required to stack such prefabricated structures or stacking must be eliminated, resulting in inefficient use of cargo space on the ship.

What is desirable, therefore, is a prefabricated building system which can be shipped and stacked without requiring additional structure, without damaging components of the building system and which makes efficient use of cargo space on a ship or other mode of transportation.

**SUMMARY OF THE INVENTION**

According to one aspect of the invention there is provided a building panel comprising: a) a plurality of frame members; b) frame member connecting means for connecting together said frame members to form a frame lying in a frame plane, the frame defining a perimeter of the panel, the perimeter bounding an interior portion of the panel; c) biasing means for biasing at least one of said frame members inwardly, generally in said frame plane, towards said interior portion of the panel; d) a first solidified castable substance cast in said interior portion of the frame, between said frame members and about said biasing means such that loads imposed on said solidified castable substance are transferred by said biasing means to said frame members.